Global Tropospheric Experiment Transport and Atmospheric Chemistry near the Equator-Atlantic (TRACE A) Langley ASDC Data Set Document

Summary

This document provides information on data products obtained during the GTE TRACE A atmospheric science expedition conducted over Eastern Brazil, the South Atlantic Ocean and South Africa during September* and October 1992. The objective of the mission were (1) to study the relative contributions of the photochemistry and the large- and small-scale circulation features to the enhanced ozone concentrations observed over the tropical Atlantic Ocean and (2) to characterize and quantify the source and transport of primary and secondary ozone precursors associated with biomass burning in South America and southern Africa. Measurements were made primarily by investigators' instruments located on the NASA DFRC DC-8 airborne laboratory. Also provided are a list of principal investigators, a brief summary of measurement techniques and a list of publications.

*Second and remaining flights delayed by one month due to repairs required to a damaged landing gear on the DC-8. Second test flight was accomplished on 9/18/92.

This document provides information for the following data sets:

trdc8mXX.zip:	Measurements acquired aboard the DC-8 aircraft during flight XX
trsat.zip:	Daily corrected version 6 TOMS data for the TRACE-A study region
trbnd.zip:	CO, O_3, N_2O, CH_4, and CO_2 measurements aboard the INPE-Brazilian Bandeirante aircraft
trsndasc.zip:	Ozonesonde data from Ascension Island
trsndcon.zip:	Ozonesonde data from Brazzaville, Congo
trsndcui.zip:	Ozonesonde data from Cuiaba, Brazil
trsndeto.zip:	Ozonesonde data from Etosha Pan, Namibia
trsndnat.zip:	Ozonesonde data from Natal, Brazil
trsndpor.zip:	Ozonesonde data from Porto Nacional, Brazil
trsndpre.zip:	Ozonesonde data from Pretoria, South Africa

Acknowledgment

The investigators involved in the TRACE A mission were funded by NASA. The funded investigators, their organization and their grant, agreement or contract were:

Area	Investigator	Organization	Grant
Aircraft	J. Bradshaw	Georgia Tech	NAG-1-1415
	E. Browell	NASA Langley	N/A
	G. Gregory	NASA Langley	N/A
	B. Heikes	U of Rhode Island	NAG-1-1395
	S. Rowland	U of California-Irvine	NAG-1-783
	G. Sachse	NASA Langley	N/A

Area	Investigator	Organization	Grant
	H. Singh	NASA Ames	N/A
	R. Talbot	U of New Hampshire	NAG-1-1233
Modeling	J. Fishman	NASA Langley	N/A
	D. Jacob	Harvard	NAG-1-1421
	T. Krishnamurti	Florida State U	NAG-1- 1312
	A. Thompson	NASA Goddard	N/A

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1. Collection Overview

a. Collection Contents

Aircraft data sets are available for each investigation for each flight. Airborne measurements were typically obtained at constant altitude over the Atlantic Ocean during transit flights (i.e. "survey" flights), and over multiple altitudes closer to Brazil and southern Africa during flight from the intensive sites. Flight missions were conducted during TRACE A from August 18 through October 26, 1992. Section 4.b lists the flight dates. Flight tracks and profiles are shown in Fishman et al., [1996]. The duration, altitude range, ascent and descent rate, and flight path for each mission varied depending on mission objectives and environmental conditions. Further information about the measurement region and time frame may be found in the Journal of Geophysical Research, Vol. 101, No. D19, 23865-23879, October 30, 1996.

Data Set Introduction

This data collection includes all of the in-situ aircraft (DC-8 & INPE Bandeirante), ozonesonde and TOMS satellite data submitted to the GTE data archive by the TRACE A investigators listed in Section 1.d. Included are the atmospheric chemistry, meteorological and navigational data recorded aboard the NASA Ames DC-8 airborne laboratory, the INPE Bandeirante aircraft, ozonesonde and TOMS satellite data. Not included in this archive are fire count satellite data, NOAA satellite imagery, rawinsondes, kinematic trajectories, modeling data and merged data sets. These data can be found at the GTE data archive.

Summary of Parameters

The atmospheric species and other parameters measured are listed in Fishman et al., [1996]. Also listed for each are the name and affiliation of the principal investigator.

b. Related Data Collections

TRACE A and SAFARI investigators have both individually reported the results of their investigations in the Journal of Geophysical Research, Vol. 101, No. D19, October 30, 1996.

There are data sets available from the Langley ASDC for 13 other GTE missions conducted from 1983 to 2001. See the GTE home page and/or ASDC GTE Data and Information page for a description of the available data.

c. Title of Investigation

Global Tropospheric Experiment Transport and Atmospheric Chemistry near the Equator-Atlantic (TRACE A)

d. Investigator Name and Title

If the person is known to be retired, deceased or no longer at the organization responsible for the investigation, it is noted and the contact information may be omitted. The contact information provided was current during the mission, but may no longer be current.

DC-8 Measurements Investigators

Investigator Area	Investigator Information
Airborne Meteorological/Position Data	John D. Barrick MS 483 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-5831 Fax: 757-864-5841 E-mail: john.d.barrick@nasa.gov
Nitric Oxide, Nitrogen Dioxide, NO_Y	John Bradshaw (Principal Investigator, Deceased) Scott Sandholm (Co-Investigator) Georgia Institute of Technology Earth and Atmospheric Sciences Baker Building, Room 107 923 Dalney Street Atlanta GA 30332-0340 Telephone: 404-894-3895/3824 Fax: 404-894-5073 E-mail: ss27@prism.gatech.edu
Aerosols and Ozone Profiles	Edward V. Browell Mail Stop 401A NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1273 Fax: 757-864-7790 E-mail: edward.v.browell@nasa.gov
In-situ Ozone, CO_2	Gerald L. Gregory (retired) NASA Langley Research Center
H_2O_2, CH_2O	Brian G. Heikes University of Rhode Island Graduate School of Oceanography South Ferry Road Narragansett RI 02882-1197 Telephone: 401-874-6810/6683 Fax: 401-874-6898 E-mail: bheikes@gso.uri.edu
Vertical Profiles of Wind, Temperature, Water	Dean Lauritsen Atmospheric Technology Division Surface and Sounding Systems Facility NCAR P O Box 3000 Boulder CO 80307-3000 Telephone: 303-497-1000 Fax: 303-497-8770
Non-methane Hydrocarbons, Hydrocarbons (C_1-C_6), Selected Terpenes and Halocarbons	F. Sherwood Roland University of California-Irvine Department of Chemistry Irvine, CA 92717 Telephone: 714-856-6016 Fax: 714-725-2905 E-mail: rowland@uci.edu
Carbon Monoxide, Methane, Nitrous Oxide	Glen W. Sachse MS 472 NASA Langley Research Center Hampton VA 23681-0001 Telephone: 757-864-1566 Fax: 757-864-8818 E-mail: glen.w.sachse@nasa.gov
PAN, PPN, C_2Cl_4, Acetone, Methanol	Hanwant Singh NASA Ames Research Center

	Singh Group Mail Stop 245-5 Moffett Field CA 94035 Telephone: 415-604-6769 Fax: 415-604-3265 E-mail: hanwant.b.singh@nasa.gov
Nitric Acid, Gas Phase Organic Acids	Robert W. Talbot University of New Hampshire Institute of Earth, Oceans, Space Morse Hall Complex Systems Research Center Durham NH 03820 Telephone: 603-862-1546 Fax: 603-862-0188 E-mail: rwt@christa.unh.edu

e. Technical Contact Information

The following persons have more specialized knowledge about the data in the data sets or in their field or general knowledge about the mission, its execution and the data sets.

Investigator or Knowledge Area	Investigator and Contact Information	
Non-methane Hydrocarbons, Hydrocarbons (C_1-C_6), Selected Terpenes and Halocarbons	Don Blake University of California-Irvine Department of Chemistry Irvine, CA 92717 Telephone: 714-856-4195 Fax: 714-725-2905 E-mail: drblake@uci.edu	
TRACE A Mission Scientist	Jack Fishman (retired) NASA Langley Research Center	
TRACE A Associate Mission Scientist	Volker Kirchhoff Instituto Nacional de Pesquisas Espaciais C. P. 515 12201 Sao Jose dos Campos Sao Paulo, Brazil Telephone: (55) 123-41-8977 Fax: (55) 123-21-8743	
TRACE A Program Manager	Robert J. McNeal (retired) NASA Headquarters	
TRACE A Project Manager	James M. Hoell, Jr. (retired) NASA Langley Research Center	
TRACE A Mission Meteorologists	T. Krishnamurti Florida State University Department of Meteorology Tallahassee FL 32306-3034 Telephone: 904-644-2210 Fax: 904-644-8579 E-mail: tkrishnamurti@fsu.edu	Henry Fuelberg Florida State University Department of Meteorology Tallahassee FL 32306-3034 Telephone: 904-644-6466 Fax: 904-644-9642 E-mail: hfuelberg@fsu.edu
TRACE A Mission Meteorological Data Manager	Mark Shipham (no longer at NASA LaRC) NASA Langley Research Center	
TRACE A Expedition Manager	Richard J. Bendura (retired) NASA Langley Research Center	
TRACE A DC-8 Aircraft Manager	Leo DeGreef (no longer at NASA Ames) Airborne Science Program Office MS D1623H Edwards, CA 93523-0273 Phone: (650) 604-4388	
TRACE A Logistics	Jacqueline Johnson (no longer at ST Systems) ST Systems Corp.	
TRACE A Experiment Integration	Leo DeGreef (no longer at NASA Ames) Joseph W. Drewry (retired) NASA Langley Research Center	

TRACE A Data Manager	Joseph W. Drewry (retired) NASA Langley Research Center		
TRACE A International Collaborators	Meinrat O. Andreae - SAFARI Max Planck Institute for Chemistry Postfach 3060 D-6500 Mainz Federal Republic of Germany Telephone: (11)49-6131-305-420 Fax: (011)49-6131-305-487	Dominique Nganga Marien Ngouabi University B. P. 69 Brazzaville Republic of Congo Telephone: N/A Fax: (011) 242-83-6642	Jannette Lindesay - SAFARI Climatology Research Group University of Witswatersrand P O Wits, Johannesburg 2030, South Africa Telephone: (011)27-11-716-2998 Fax: (011)27-11-716-3000

2. APPLICATIONS AND DERIVATION

Potential usage and applications of the described data sets can be seen in the articles that comprise the Journal of Geophysical Research TRACE A Special Section (Vol.101, No. D19 October 30, 1996) and the Second Scientific Conference of the International Global Atmospheric Chemistry (IGAC) Project, September 1994.

a. Calculated Variables

For convenience of the users, the calculated variables below are provided.

Mach Number, M:

$$M = \sqrt{5 * \left[\left(\frac{Q_c}{P_s} + 1 \right)^{(2/7)} - 1 \right]}$$

M = Mach Number
Ps = Static Pressure
Qc = Differential Pressure

Static Air Temperature, Ts:

$$T_s(^\circ K) = \frac{T_T}{\left[1 + M^2 * \left(\frac{\gamma - 1}{2} \right) \right]}$$

T_S = Static Air Temperature (°K)
T_T = Total Air Temperature (°K)
γ = 1.4, ratio of specific heat of air at constant pressure and volume

True Air Speed, TAS:

$$TAS(kts) = M * a = M * 38.96695 * \sqrt{T_s}$$

TAS = True Air Speed (knots)
T_S = Static Air Temperature (°K)
M = Mach Number
a = Speed of Sound

Potential Temperature, θ:

$$\theta(^\circ K) = T_s * \left(\frac{1000}{P_s} \right)^{0.2857142}$$

θ = Potential Temperature (°K)
T_S = Static Air Temperature (°K)
Ps = Static Pressure (mb)

Vapor Pressure, e :

e_{water} (mb) = [1.0007 + (3.46 * 10^{-6} * P_S)] * 6.1121* EXP[17.502 * T/(240.97 + T)]

e_{ice} (mb) = [1.0003 + (4.18 * 10^{-6} * P_S)] * 6.1115* EXP[22.452 * T/(272.55 + T)]

e = Partial Pressure of Water Vapor (mb)
P_S = Static Pressure (mb)
T = Static Air Temperature (°C) for Saturation Vapor Pressure
or
T = Dew/Frost Point(°C) for Partial Pressure of Water Vapor

Note:

1. ProjDP of zero or greater should be used to derive the partial pressure of water vapor w.r.t water (e_{water}) and the ProjDP less than zero should be used to derive the partial pressure of water vapor w.r.t ice (e_{ice}).

2. StatTempDegC and ProjDP parameters recorded in the P-3B data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor , respectively.

3. TSDEGC and ProjDP parameters recorded in the DC-8 data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively. Also notice in the DC-8 data set there is a redundant static air temperature measurement, TSCALC, which is calculated by DADS. Although TSDEGC and TSCALC track closely they can diverge by ?1° at the low and high ends of the measurement range.

Specific Humidity, q:

$$q(g/kg) = \frac{0.622 * 10^3 * e}{(P_s - 0.377e)} \qquad q(ppmw) = \frac{0.622 * 10^6 * e}{(P_s - 0.377e)}$$

Mixing Ratio, r:

$$r(g/kg) = \frac{0.622 * 10^3 * e}{(P_s - e)} \qquad r(ppmw) = \frac{0.622 * 10^6 * e}{(P_s - e)}$$

Note:
ppmv = 1.608 * ppmw
ppmw = 0.622 * ppmv

Relative Humidity, %:

w.r.t. water,

$$RH_{water} = \frac{e_{water}}{e_{S_{water}}} * 100$$

w.r.t. ice,

$$RH_{ice} = \frac{e_{ice}}{e_{S_{ice}}} * 100$$

b. Graphs and Plots

Interested readers should see the Journal of Geophysical Research, Vol. 101, No. D19, October 30, 1996, and documents referenced therein, for plots and the results of analysis of data.

3. DATA DESCRIPTION AND ACCESS

a. Format

See the GTE Data Format Document.

b. Data Organization

Granularity

A general description of data granularity as it applies to the IMS appears in the EOSDIS Glossary. Aircraft data sets are available for each investigation for each flight.

c. Data Collection Status and Plans

This data set contains all of the in-situ aircraft (DC-8 and Bandeirante), ozonesonde and TOMS satellite data submitted to the GTE data archive by the TRACE A investigators listed in Section 1.d. Included are the atmospheric chemistry, meteorological and navigational data recorded aboard the NASA Ames DC-8 airborne laboratory, the INPE Bandeirante aircraft, ozonesonde and TOMS satellite data. Not included in this archive are fire count satellite data, NOAA satellite imagery, rawinsondes, kinematic trajectories, modeling data and merged data sets. These data can be found at the GTE data archive. No additional data products relevant to TRACE A are anticipated.

d. Data Access

This data is available online or on a CD-ROM via the LaRC ASDC on the GTE Data and Information Page and from the GTE data archive.

e. Data Archive Center

The Atmospheric Science Data Center at NASA's Langley Research Center.

Contacts for Data Center or Data Access Information:

User and Data Services Group
Atmospheric Science Data Center
MS 157D
Langley Research Center
Hampton, VA 23681 USA
Phone: 757-864-8656
Fax: 757-864-8807
E-mail: support-asdc@earthdata.nasa.gov
Internet: http://eosweb.larc.nasa.gov

f. How to Cite the Data Collection

Publication of a portion(s) of the data archive should acknowledge the principal investigator(s) responsible for the data by referencing the appropriate manuscript in the Journal of Geophysical Research, Vol. 101, No. D19, October 30, 1996.

4. DATA CHARACTERISTICS

a. Study Area

Airborne measurements were made over Brazil, the South Atlantic Ocean and southern Africa. A more detailed description of the surface level environmental characteristics for the experiment region is provided in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 101, No. D19 October 30, 1996. Additional information may be found in other publications authored by the principal investigators or on the GTE homepage.

Spatial Coverage

TRACE A flight missions were conducted during September and October, 1992. The duration, altitude range, ascent and descent rate, and flight path of each mission varied depending on mission objective and environmental conditions. The nominal airspeed ranged from greater than 500 knots (approximately 575 mph) at 11 km altitude to 150 knots (approximately 175 mph) at 3.7 km.

Data Platforms	Min Lat	Max Lat	Min Lon	Max Lon
DC-8 Aircraft	38S	44N	126W	40E
Bandeirante Aircraft	17S	10S	56E	48W
TOMS	40S	10N	50E	80W

Ozonesonde Launch Site	Latitude	Longitude
Ascension Island	8.00S	15.00W
Congo	4.28S	15.25E
Cuiba	15.30S	56.00W
Etosha	19.20S	15.90E
Natal	6.00S	35.00W
Porto	10.80S	48.40W
Pretoria	25.90S	28.20E

Spatial and Temporal Resolution

Resolution varies for each measurement. See individual data file headers for resolution of measurements made aboard aircraft.

Grid Description

No data gridding or binning of data to a geographic grid occurred during data processing.

b. Temporal Coverage

TRACE A aircraft missions were conducted from 08/18/92* through 10/31/92. The dates and times for each mission are given in Fishman et al., [1996]. Ground site measurements were obtained from (date) to (date).

Data Platform	Begin Date	End Date
DC-8 Aircraft	08/18/92*	10/26/92
Bandeirante Aircraft	09/09/92	10/01/92
TOMS	09/01/92	10/31/92
*Second and remaining flights delayed by one month due to repairs required to a damaged landing gear on the DC-8. Second test flight was accomplished on 09/18/92.		

Ozonesonde Launch Site	Begin Date	End Date
Ascension Island	07/28/90	10/24/92
Congo	04/06/90	10/20/92
Cuiba	09/18/92	10/10/92
Etosha	090/9/92	10/18/92
Natal	03/12/90	10/23/92
Porto	09/15/92	10/01/92
Pretoria	09/02/92	10/07/92

c. Parameter or Variable

Not all of the parameters are in each data set granule. Also, the ranges vary between data sets and between granules within each data set. Species measured are given in Fishman et al., [1996].

Parameter Description
The variables measured are standard atmospheric chemical and meteorological species requiring no further elaboration here.

Unit of Measurement
The units of measure vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 101, No. D19, October 30, 1996.

Parameter Range
The ranges of data vary widely depending on species and measurement environment and are addressed in the individual papers for each investigation included in the Journal of Geophysical Research, Vol. 101, No. D19, October 30, 1996.

Sample Data Record
The GTE Data Format Document contains examples of each data set type.

d. Error Sources

The sources of error vary depending on species and measurement environment and are addressed in the papers included in the TRACE A special issue of the Journal of Geophysical Research, Vol. 101, No. D19, October 30, 1996, and/or papers referenced in that publication and readme files and/or header records associated with each data file.

5. USAGE GUIDANCE

a. **Known Problems with the Data:**

None reported for the current archive version. See the readme files and header records included with each data set for information provided by the responsible investigator.

b. **Future Modifications and Plans:**

The data sets submitted to the ASDC are considered final and no further updates are planned.

6. ACQUISITION MATERIALS AND METHODS

Details of data acquisition and materials are addressed in the papers contained in the Journal of Geophysical Research TRACE A Special Section (Vol.101, No. D19, October 30, 1996) and the Second Scientific Conference of the International Global Atmospheric Chemistry (IGAC) Project, September 1994

7. REFERENCES

Journal of Geophysical Research, Vol. 101, No. D19, October 30, 1996.

Second Scientific Conference of the International Global Atmospheric Chemistry (IGAC) Project, Fuji-Yoshida, Japan, September 5-9, 1994.

GTE Bibliography: Citations for publications, presentations, and media coverage

Fishman, J., J. M. Hoell, R. D. Bendura, R. J. McNeal, V. W. J. H. Kirchhoff, NASA GTE TRACE A Experiment (September-October 1992): Overview, J. Geophys. Res., Vol. 101, 23865-23879, October 30, 1996.

8. ACRONYMS

ASDC - Atmospheric Science Data Center
Bnd - Brazilian airplane (Bandeirante)
DFRC - Dryden Flight Research Center
EOSDIS - Earth Observing System Data and Information System
FSU - Florida State University
GTE - Global Tropospheric Experiment
IMS - Information Management System
INPE - Instituto Nacional de Pesquisas Espaciais
LaRC - Langley Research Center
NASA - National Aeronautics and Space Administration
NCAR - National Center for Atmospheric Research
NOAA - National Oceanographic and Atmospheric Administration
ProjDP - Project Dew Point
SAFARI - Southern African Fire-Atmosphere Research Initiative
TOMS - Total Ozone Mapping Spectrometer
TRACE A - Transport and Chemistry near the Equator in the Atlantic
TSCALC - Static temperature, calculated by DADS
TSDEGC - Static temperature, measured directly, in Celsius

9. Document Information

- **Creation Date:** October 1996
- **Revision Date:** Oct 1996; May 1997; Nov 1997; Nov 2003
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- **Identification:**
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